it was not far to the east of the coast. During the night of the 22nd the wind shifted to the NW. at stations south of New England, and the barometric gradient increased rapidly in front of the storm as the centre approached the New England coast. Rain and snow prevailed in the Lower Lake region, Middle States and New England, on the 22nd and 23rd, and dangerous winds occurred at all coast stations north of Wilmington, N. C. The barometer continued to fall at the centre until the storm reached the coast line, near Portland, on the morning of the 23rd, when the reading was 29.26. Severe easterly gales were reported from the St. Lawrence valley, New Brunswick and Nova Scotia. The maximum velocity report at Eastport was 53 miles from the E., 42 miles at Father Point, high winds at Quebec and 33 miles from the N. at Saugeen. After reaching the coast of Maine the course changed to the N., and by midnight of the 23rd the centre had passed to the lower St. Lawrence valley near Father Point. Cautionary Signals were ordered at all stations on the Lower Lakes and on the Atlantic coast, and were justified at all stations north of Wilmington.

No. IX.—This depression developed in the Upper Missouri valley, while the preceeding one (No. VIII,) was central in the Gulf of St. Lawrence. It moved almost directly east over the parallel of 45° until it passed to the east of the Atlantic coast on the 27th. During the 25th the centre moved from Dakota to the Upper Lake region, its approach having been announced by the display of Signals at the lake ports. The centre passed over Lake Michigan immediately north of Milwaukee, the area of rain extending south to Tennessee and east to the Atlantic coast. The Cautionary Signals displayed were generally justified, except in New England.

No. X.—This storm developed in the tropics and was central in the Gulf of Mexico, east of Brownsville at the p. m. report of the 27th. Heavy rains and cold northerly winds prevailed on the Texas coast. Indianola reported a maximum velocity of 56 miles on the 27th. The "norther" continued on the Texas coast as the centre moved toward the Mississippi and the area of rain extended north to the Ohio valley and the southern portion of the South Atlantic States on the 28th. The average hourly velocity of this storm was 19 miles, in a northeast direction over a course nearly parallel to the coast. Rain fell in all districts east of the Mississippi, the rain-fall being greatest in the Southern States and near the centre of the storm as it moved over the Middle States and New-England. The barometer fell rapidly as the depression moved to the northeast and at the p. m. report of the 31st, a large area including the greater portion of New England, was completely inclosed by an isobarometric line of 29.30. Over an inch of rain fell during the last eight hours of the 31st at Portland, Eastport and Father Point. A maximum velocity of 40 miles from the SE. was reported at Eastport, when the centre was to the northwest of this station in Maine. The Cautionary Signals displayed in advance of this storm gave timely warnings and were of great service, especially at the ports on the northeast coast.

No. XI.—This depression was first observed in the Northwest, near the northern boundary of United States, at the p. m. report of the 27th, and continued in that region until the midnight report of the 28th, when it apparently joined an area which had passed from the Pacific coast. This depression although extended, was slight and after moving slowly to the east until the p. m. report of the 29th, disappeared.

No. XII.—This was a slightly marked area central in the interior of California on the 28th, and the movement to the east can be readily traced on the Study-Map of "Departures from the Normal." It appears to have united with the preceeding one, near Deadwood, at the midnight report of the 28th.

INTERNATIONAL METEOROLOGY.

Three International charts, Nos. IV, V and VI, accompany the present Review. They are for the months of *September*, 1880 and *February*, 1879.

Chart No. IV.—On this *preliminary* chart are shown, as well as is at present possible, the tracks of some of the principal storms centres over the North Atlantic Ocean and adjacent land areas during the month of *September*, 1880. Nos. I and II are the extended tracks of the tropical storms already described in previous *Reviews*. It seems probable that these storms united in forming a large area of low barometer over the northwestern portion of the Atlantic during the 6th, and which moved slowly eastward, unaccompanied by severe winds, until it disappeared on the 11th to the northwest of Scotland. The high barometer prevailing to the northward of the centres of the two cyclones above referred to may be here noted as an interesting feature in connection with the two storms, and by which the severity of the winds in the northern quadrants were increased. Thus on August 27th and 28th, while the former cyclone was approaching the coast of Florida, high pressures (from 30.20 to 30.30) were prevailing throughout the Atlantic States and Canada, and during the first few days of September, while the latter cyclone was moving eastward from the Bermudas high pressures, increasing on September 2nd to 30.35, prevailed between it and Newfoundland. The disturbance formed by the probable junction of these cyclones was preceded over the northeastern portion of the Atlantic by a somewhat severe storm, whose path is shown on the chart as No. IV. It appeared on the morning of the 3rd. Bark *Carrie Heckle* reports 3rd, 7:35 a. m., W. T., 50° N. 26° W., barometer 29.70, S. by W., fresh, threatening; 4 p. m., G. T., wind came from the north and blew a gale all night, accompanied by very heavy rain-squalls; early on the morning of the 4th, barometer rising, the wind backed to WNW., with clearing weather. On the 4th, S. S. *Indiana*, in

52° N. 22° W., reported barometer 29.30, SW. force 8, heavy NW. sea. This area of low pressures is interesting by reason of its breaking the regime of high pressures and consequent fine weather, which had prevailed over northwestern Europe, and especially over the British Isles, during the greater part of August, or since the passage of area No. III, of chart IV, September Review. The *Bulletin* of the Central Meteorological Bureau of France states that in France, the winds, which since August 10th had been easterly changed to westerly on the morning of September 5th. The next Atlantic storm (No. V.) moved in a northeasterly path, central at some distance off the American coast, and was noticed in the September REVIEW as low area No. II. This storm probably originated north of the Bahamas on the 7th. On the 8th, hurricane winds from SW. were experienced in 33° N. 73° W. by Barks *New Light* and *Eastern Star*, while further northward the hurricane winds were first experienced from the eastward. Steamer *Arrow* in 34° 40′ N. 74° W., very near the centre, but evidently in the north quadrants, reported: 8th, 2 a. m., barometer fell to 29.40, with wind blowing hard from southward; 3 a. m., barometer falling fast, wind veered to SE., with violent squalls and heavy confused seas; 4 a. m., 29.15, wind "veering" rapidly from E. to NE., N. and NW.; 6 a.m., barometer rising; 8 a. m., rising steadily, wind WNW., with heavy confused seas. Brig't. *T. H. A. Pitt*, in eastern quadrants, reports: 8th, 42° 05′ N. 64° 30′ W., NE. breezes, cloudy; 6 p. m., wind freshening, thick rain; midnight, NE. fresh gales, barometer 30.00, wind increasing rapidly and hauling southerly; 9th, 3 a. m., 29.50, perfect hurricane; 5 a. m., 29.40, wind SSW.; 10 a. m., wind moderating and hauling to westward. On the 9th, it passed eastward south of Nova Scotia as a very severe storm, but with the pressure apparently increasing. S. S. *Britannic* reports, 9th, 44° N., 58° W., 9 a. m., 30.24, SSE. force 4; 10 a. m., 30.13, wind increasing, heavy rain; noon, 30.06, strong breeze, heavy rain; 2 p. m., 29.85, wind suddenly hauled to SW. and increased to a violent gale, sea rising rapidly causing the vessel to plunge and labor heavily and filling decks with water; 4 p. m., 29.85, similar weather; 6 p. m., 29.95, wind and sea moderating. On the morning of the 10th, low pressures were experienced at St. John's, Newfoundland, and during the day, stormy weather from the SW. prevailed in 48° N., 45° W., as the storm probably passed to the northward. The next storm (No. VI) which followed quickly in rear of the preceding, and was noticed in the September REVIEW as low-area No. III, does not appear to have been as severe a storm while over the western Atlantic, but to have rapidly developed an increase of energy during the 13th, as it approached the European coast. Several reports are to hand of hurricane winds on this day over the eastern Atlantic, between 45° and 55° N., but the following record will serve to show the severity of the storm. S. S. *Scythia*, 13th, 7:35 a. m., W. T., 51° N., 15° W., 29.74, SW'ly. 4, frequent showers and high cross sea; 4 p. m., 29.27, SSW., strong breeze, heavy rain; 6 p. m., wind shifted to WNW; 6:50 p. m., lowest barometer, 28.82; 8 p. m., 29.05, NNW. moderate gale; 8:30 to 10 p. m., gale, with heavy rain, sea running high, very fierce squalls; midnight, 29.35, moderate gale, sea still high; 14th, 4 a. m., 29.65, N. strong gale, heavy sea; 7:35 a. m., W. T., 50° N., 21° W., 30.04, NNW., 7, heavy rain, rough sea. During the 14th, 15th and 16th, this area moved eastward to the English Channel as a very severe storm, a wind force of 9 (scale 0-9) being recorded during these days at Scilly, Cherbourg and the Hague. Severe north gales prevailed in its rear, and on the summit of Pic-du-midi; during the night of the 16th, the temperature fell to —3°.2 C., or 26°.2 F., with snow. In general, during the 15th and 16th, quite high pressures prevailed over the ocean. S. S. *Scythia*, in 49° N., 29° W., reporting a barometric reading of 30.57 and ship *Jumna* in 51° N., 39° W., 30.45, on the 15th, and S. S. *Illinois* in 44° N., 45° W., 30.42 on the 16th. During these days, the area of low barometer, already described in the September REVIEW as low-area No. V. and shown on the present chart as area No. VIII moved northward over New England, New Brunswick and Labrador, and on the 17th, a new depression (No. IX) appeared over the eastern half of the ocean, which subsequently moved eastward to Denmark. On the 23rd, the low-area described in the September REVIEW as area No. VIII, had moved to the eastward of Newfoundland and on the 24th, formed an extensive area of low pressures, which apparently included the greater part of the ocean between the 40th and 60th parallels. On the 25th, the region of minimum pressure had advanced eastward to the 25th meridian, but on the 26th, is found more to the westward, near the 40th meridian and in the position indicated on chart by area No. XIV. During the rest of the month, this area remained central over mid-ocean, and on the night of October 1st, was marked by severe southerly gales at the Azores, during which, the three steamers *Benalla*, *Robina* and *Stag* foundered off St. Michaels.

Chart No. V.—Upon this chart are shown the mean pressure, mean temperature, mean force and prevailing direction of the wind at 7:35 a. m., Washington time (0:43 p. m., Greenwich time) for *February*, 1879, over the Northern, and, at a few isolated stations, in the Southern Hemisphere. A zone of comparatively *high pressures* apparently extending from the eastern coast of Asia westward over that continent, over northern Africa, where, however, it is broken through lack of observations, over the southern half of the Atlantic, and thence over the United States to the Pacific. The regions of greatest pressure are found over the centre of Asia, (above 30.30 or 769.6) over the southeastern portion of the Atlantic (30.30) and over the interior of North America (30.20 or 767.1.) An extensive region of *low pressures* covers the Atlantic north of the 45th parallel and almost the whole of Europe, reaching from Labrador and Nova Scotia on the west to the Ural Mountains and Black Sea on the east. The region of minimum pressure (under 29.50 or 749.3) includes Iceland, Ireland and the western coast of Scotland. Com-

paratively low means are found at the mouth of the Amoor and near the Equator, as shown by observations at Nikolaievsk; near the isthmus of Panama; along the west African coast from 10°N to 10° S; at Natal; Mauritius; in southern Hindostan and at the Philippines. The *winds* may be classed as *northerly* or *westerly* and *northeasterly*. Over North America the direction is *northwesterly*, trending to northerly along the Gulf and South Atlantic coasts and to westerly over Canada; this westerly current extends over the whole Atlantic between the 35th and 55th parallels inclining to southwest near mid-ocean and along the European coast, the latter direction being sustained over all of southern Europe, and over southern Russia inclining still more to southerly. The *northeasterly* current predominates over the Atlantic south of 30° N from the West Indies to the coast of Africa; over the extreme northern portions of the Atlantic and Europe from Godthaab, Greenland, to northwestern Russia, and along the western coast of Asia from Niphon to the China Sea. The region of *greatest cold* appears to be over British America, the monthly mean (7:35 a. m. Washington time) of York Factory being —33°. The absolutely highest and lowest barometer readings (corrected and reduced) reported by the co-operating observers were 31.00 or 787.3 on the 24th at Ekaterinburg and 28.44 or 722.4 on the 10th by S. S. Leipzig, in 49°.03′ N. 15°.20′ W., showing a total monthly barometric range over the Northern Hemisphere of 2.56 inches. In the monthly weather review of the *Deutsche Seewarte*, for this month the lowest reading reported is 711.6 or 28.02 on the 9th on board Steamer *Donau* in 49° N. 30° W., while the highest reading reported in the *Bulletin* of the Cent. Phys. Obsy. of St. Petersburg is 791.1 or 31.15 at Irkutsk on the 27th, showing a range of 3.13 inches. On board the *Vega*, frozen in in 67° 7′ N., 173° 30′ W., the mean temperature of the month was —13°.1 F. or —25°.1 C.; the maximum pressure 31.03 or 788.1, was recorded at 6 a. m. of the 17th. Upon comparing the present chart with the one presenting similar means for the same month of the previous year, the greatest changes are found over the Atlantic ocean and Europe and over the Behring's Sea region. Instead of the two areas of low barometer in 1878, located, respectively, over the western portion of the Atlantic and to the north of Norway, there is now found one large area over the extreme northeastern part of the ocean, which, extending its influence southeastwardly over Europe, produces a diminution of pressure over the western and central portions of that continent of from 0.50 to 0.60 of an inch, at the same time that an increase in pressure (amounting to about 0.35 inch) is found over northeastern Europe and in the Ural region. As a result of this changed distribution of pressure, the temperature over northern Europe, under the influence of the easterly current referred to above, underwent a decided diminution, amounting to about 10° F. over Finland, Scandinavia and the North Sea, and about 5° over the British Isles, Iceland and contiguous portion of the Atlantic. Towards the centre of Europe, the diminution in temperature is less marked, and at extreme south and in the southeast a decided increase is noted, which at Beirut, amounts to 10° F. Over the Atlantic, in the region occupied by the low-pressure of 1878, a barometric rise of 0.30 to 0.50 inch is noted, with an apparent slight increase of temperature. Over the North American continent, there is also a general increase in pressure amounting in Alaska to 0.60; in Washington Territory to 0.30 and from Manitoba to the Gulf States, to about 0.20 inch, with a large decrease of temperature over the whole region east of the Rocky Mountains. At York Factory, the temperature in 1878 was —1°.7 and in 1879, —33°. Over Asia, and especially along the Chinese coast, the pressure is diminished, the decrease amounting to 0.17 at Pekin and 0.15 at Shanghai. At the same time, in the latter region, the winds which were NW. in 1878, are now SE'ly., with an increase in temperature of 5° at Hong Kong, 4° at Shanghai and 19° at the mouth of the Amoor. Notwithstanding the great increase of pressure (0.60 in.) at St. Michael's, Behring's Sea, the temperature at this station shows an increase of 13°. As compared with the preceding month, January, 1879, the the most marked changes are: 1st, the change of position of the low-area over the Atlantic from the Northwest to the Northeast and a removal of the high pressure from Europe; 2nd, the large increase in pressure of more than half an inch over the Behring's Sea region; and 3rd, a decided contraction of the area of high pressure over Asia.

Chart No. VI.—Upon this chart are traced the paths of 27 of the principal storm-areas of the northern hemisphere, during the month of *February*, 1879. Of these, 8 are located along the eastern coast of Asia, or over the Behring's Sea region; one over central Asia, and the remainder (18) over North America, the north Atlantic or Europe. Of the 12 over North America, one, No. I, properly belongs to the preceding month, as it cannot be traced after the morning of the 1st; two, Nos. VII and XIV, appeared over Hudson Bay, and are based upon the reports of York Factory and Moose Factory; five, Nos. VIII, X, XVII, XXV and XXVII, developed or first appeared in the Rocky Mountain region; three, Nos. XI, XVIII and XXI, appeared on the Pacific coast on the 8th, 17th and 20th, respectively, and subsequently crossed the continent, and one, No. IV, appears to have slowly developed over the Canadian maritime Provinces in the trough of low pressures left by area No. XXVIII, of January. Of the low areas leaving the American coast, the unusually large number of five can be traced across the Atlantic to the vicinity of the European coast; two, Nos. XVIII and XXV, passed northward over Newfoundland and Labrador, respectively, towards Davis Straits, while two, Nos. I and XVII, appeared to die out over the western portion of the ocean. Of the European storms, four, Nos. III, VIII, X and XI, can probably be traced back to the American coast; two, Nos, VI and XVI, first appeared, respectively, over Norway and the British Isles, and one, No. XV, over the Gulf of Bothnia; two, Nos. XXIII and XXIV, appeared successively on the 23rd and 24th,

over southern Europe and Algeria, and subsequently moved in very similar paths north-northeastward to the Baltic. Of the six areas located on the eastern coast of Asia, three, Nos. II, IX and XIII, occurred during the first portion of the month, and are, from their positions, necessarily poorly defined, as was also No. XIX, which probably passed eastward over Niphon during the night of the 18th. Nos. XXII and XXVI, occurring respectively from the 21st to the 25th, and from the 26th to the 1st of March, were, however, pretty well marked areas, and the general direction of the paths, as well as the positions of the centres, are probably almost correct. The first of these, namely, No. XXII, appears to have developed during the 21st over the China Sea region, on which day the barometers at Hong Kong, Manilla and Shanghai, registered the second decided minima of the month. During the 22nd it was followed at Manilla and Shanghai by NW. winds, (the only NW. wind of the month reported from the former station,) and moved towards the NE., apparently only a short distance off the coast of Niphon, and thence northward to the Okhotsk Sea. The lowest barometer-readings of the month occurred at the following stations during the passage of this area, and in the order given:

STATIONS.	Date.	Time.		Barometer.		Winds.
	Feb. 1879.	*Local.*	*Wash. mean.*	*Inches.*	*Mm.*	(1) (2) (3)
Manilla	21st	8:47 p. m.	7:35 a. m.	29.80	757.0	SSE.— SSE.— NW.
30° N. 129° E., S. S. Belgic	21st	9:19 p. m.	7:35 a. m.	29.77	756.2	(——)— SSW.— (——)
Nagasaki	22nd	3:30 p. m.	1:42 a. m.	29.62	752.3	WSW.—NNW.—N.
Hiroshima	22nd	3:30 p. m.	1:22 a. m.	29.60	751.8	S.— NNE.— NW.
Kobe	22nd	9:43 p. m.	7:35 a. m.	29.46	748.3	N.— NE.— NNE.
Yokohama	23rd	11:30 a. m.	9:02 p.m , 22nd	29.05	737.9	N.— N.— N.
Tokio	23rd	9:30 a. m.	7:02 p.m., 22nd	29.07	738.5	NW.— NNW.— NNW.
Nikolaievsk	25th	7:00 a. m.	10:07 p.m., 24th	29.40	746 7	W.— W.— S.

The wind directions are for the observations at times of lowest barometer (2) and for the same hours of the preceding (1) and succeeding (3) days. At Nagasaki the wind, at 3:30 p. m. of the 21st, was from WSW. as given in table but at 9:10 p. m. it was NE. At Tokio a similar change occurred, the wind at 9:30 a. m. 22nd being NW. and from 3 to 4 p. m. NE; at 3 a. m. 23rd, it veered N. to NNW. and increased to its maximum velocity (29 miles per hour) at 11 a. m.. The heaviest rains of the month were also recorded during the regime of this storm. Nagasaki recording 2.30, Hiroshima, 1.40, Yokohama, 2.96, and Tokio, 3.01 inches. Steamer *Belgic*, from Yokohama to Hong Kong, encountered the storm during the 21st and 22nd; on the latter date she was in 28° 43′ N, 125° 34′ E. and had barometer 29.85, wind N., force 7 (0–12) with rough, cross and turbulent sea. The area No. XXVI appears to have developed over the interior of China, and to have moved in a path somewhat to the north of Shanghai and the Island of Niphon. The following table gives data for this storm similar to the above:

STATIONS.	Date.	Time.		Barometer.		Winds.
	Feb., 1879.	*Local.*	*Wash. mean.*	*Inches.*	*Mm.*	(1) (2) (3)
Pekin	25th	8:27 p. m.	7:35 a. m.	30.02	762.4	Calm— SW.— Calm.
Tientsin	25th	8:32 p. m.	7:35 a. m.	29 95	760.8	E. by N.— E.— ENE.
Macao	26th	8:19 p. m.	7:35 a. m.	29.89	759.2	ENE.— NE.— SW.
Shanghai	27th	2:00 p. m.	12:46 a. m.	29.74	755.4	SE.— WSW.— NW.
Manilla	26th & 27th	8:47 p. m.	7:35 a. m.	29.82	757.4	SSE.—ESE.— SW.
Nagasaki	28th	3:30 p. m.	1:42 a. m.	29 64	752.9	SE.— SE.— NW.
Hiroshima	28th	9:30 p. m.	7:32 a. m.	29.78	756.4	(——.) — N.— NNE.
Kobe	28th	8:47 p. m.	7:35 a. m.	29.91	759.7	ESE.— SE.— WNW.
Vladivostok	*Mar.* 1st	7:00 a. m.	4:04 p. m., 28th	29.86	758.3	ESE.— N.— Calm.
Yokohama	1st	10:00 p. m.	7:35 a. m., 1st	30.03	762.7	S.— Calm— NNE.
Tokio	2nd	3:30 a. m.	12:52 p m., 1st	29.92	760.0	SE.— N.— NE.
Nikolaievsk	2nd	7:00 a. m.	4:18 p. m., 1st	29.54	750.4	Calm— E.— Calm.

This area was followed along the coast of China by severe northerly gales and snow. At Tientsin the wind reached a force of 8 (scale 0 to 12); at Tchefow, on the southern coast of the Gulf of Petchely, a violent northerly gale and high tide were experienced; at Shanghai it reached 30 miles per hour at 2 p. m. of the 28th, and at Vladivostok, force 8 (0–12) on the morning of March 1st. From the preceding data the progressive velocities of the centres of these two storms may be estimated at about 25 miles per hour.

In Behring's Sea region high pressures predominated during the greater part of the month, and only three low areas, Nos. II, V and XII, are indicated on the chart. The two former were quite severe storms; the wind at St. Michael's on the 2nd reached 67 miles per hour from the south, and at St. Paul's Island on the 6th, 49 miles from the southeast. After the disappearance of area No. II on the 7th, a decided rise of barometer set in at these stations which continued almost uninterrupted at St. Michael's until 3 p. m. of the 17th, when the barometer read 30.859; at St. Paul's there was a slight interruption on the 10th and 11th, but the pressure recovering, the maximum, 30.679, was reached at 9 p. m., 17th, and 7 a. m. of the 18th; after these dates the barometer fell at both stations until the 22nd. During the regime of this extraordinary high barometer area, northerly winds and gales prevailed and at St. Michael's the temperature fell to —30° on the 18th. After the 22nd lower pressures were experienced with the centre of depression apparently to the southeast of the stations.

TEMPERATURE OF THE AIR.

The mean temperature of the air during October, 1880, is shown by the isothermal lines in red on chart No. II. In the Southern States east of the Mississippi river, and in the Middle States, the